ROTARY POSITIVE DISPLACEMENT UNIT

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Abstract of **GB1472291**

1472291 Rotary positive displacement devices W C BLYTHING 24 Dec 1974 [8 Jan 1974] 00820/74 Heading F1F A rotary positive displacement device comprises a housing and two rotors which on adjacent faces have regularly spaced, radially extending teeth with one rotor having one more tooth than the other and the rotational axes of the rotors are inclined so that the spaces between the teeth vary cyclically. The outer surface defined by the two rotors is spherical and is engaged by the inner, similarly shaped surfaces of two (as shown) or more ring members 22, 23 which are apertured to allow fluid- flow into and out of these spaces from and into inlet and outlet passages in the housing. As described, the ring member 23 has a series of apertures 28 with respective non return valves 29 which communicate via an arcuate port 27 in the casing with an inlet duct 25 and this ring is rotat- able by a handle (not shown) to control fluid-flow into the teeth spaces. A similar arrangement is on the outlet side of the device in the ring member 22. Alternatively the apertures may be replaced by a respective slot in each ring member.

FIG. 1

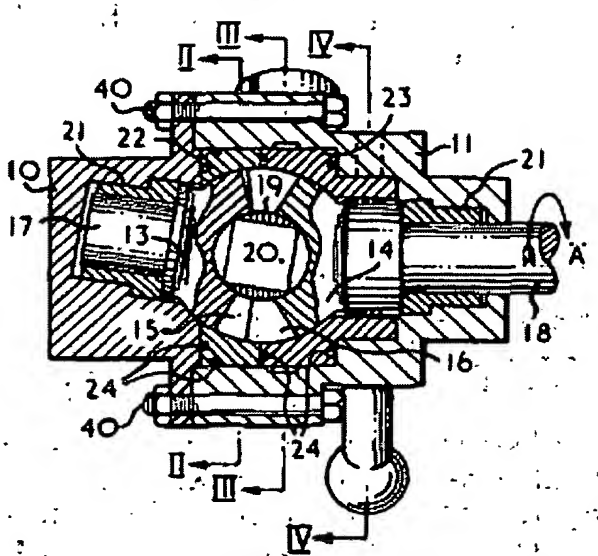
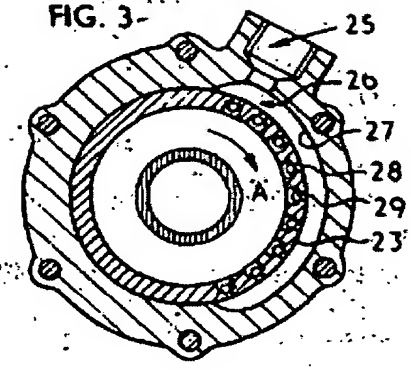


FIG. 3



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(54) A ROTARY POSITIVE DISPLACEMENT UNIT

(71) I, WILLIAM CHARLES BLYTHING, of 37 Pendragon Road, Perry Barr, Birmingham B42 1RN, a British subject, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a rotary positive displacement unit of a kind comprising a housing and two rotors mounted in the housing, each rotor having a face formed with regularly spaced and radially extending teeth, there being one more tooth on one rotor than on the other, the rotors being arranged for rotation relative to each other with their teeth in mesh and with their axes of relative rotation inclined with respect to each other whereby, when the rotors rotate, relative rotation between the rotors occurs and the teeth of the rotors move alternately into and out of mesh to produce a cyclic variation of the volumes between the teeth of the rotors, portions of the rotors adjacent to and including the teeth having a common spherical outer surface. Hereinafter such rotary positive displacement units will be referred to as being "of the kind described".

Such a unit is described and claimed in British Patent Specification No. 1099085. A unit of the kind described is also described in British Patent Specification No. 1 273 987 which includes claims to a manner of manufacturing suitable toothed rotors for such units.

The present invention consists in a rotary positive displacement unit of the kind described and in which the axes of relative rotation of the rotors are fixed relative to the housing and both the rotors rotate relative to the housing, wherein the rotors are located in a ring assembly comprising two or more ring elements defining a common spherical internal surface which sealingly engages the common spherical outer surface of the rotors, the ring assembly being apertured to enable fluid communication to take place between the exterior of the housing, through ducts in the housing, and the volumes between the teeth of the rotors in the arc of movement of the rotors where the volumes are increasing and in the arc of movement of the rotors where the volumes are decreasing.

One of the ring elements of the ring assembly may be integral with and be formed by a part of the housing of the unit.

A first one of the ring elements may be apertured to enable fluid communication with the volumes between the teeth in the arc of movement of the rotors where the volumes are increasing and a second one of the ring elements may be apertured to enable fluid communication with the volumes between the teeth in the arc of movement of the rotors where the volumes are decreasing. The first ring element may be arranged to enable fluid communication with the volumes between the teeth over a selected length of and to a given point in the arc of movement of the rotor where the volumes are increasing and this first ring element may be adjustably movable to shorten that length and to terminate fluid communication at an earlier point in the arc of movement of the rotors. In this way the fluid flow through the unit can be varied for one speed of rotation of the rotors by regulating the amount of fluid which can enter into each of the volumes between the teeth of the rotors.

The present invention also consists in a hydrostatic transmission system including a rotary positive displacement unit according to the present invention.

The system may include a fluid coupling comprising a rotary positive displacement unit of the kind described. One such fluid

coupling is described in and illustrated in Figure 2 of British Patent Specification No. 1 273 987.

An input shaft of the fluid coupling may be arranged to drive an input shaft of the unit according to the present invention and the coupling and unit may be hydraulically connected together in series whereby variation in the speed of the input shaft of the fluid coupling causes a variation in the fluid flow rate of the unit and of the fluid coupling. In such a system it is possible to obtain an infinitely variable power transmission.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings in which:—

Figure 1 is a sectional side view of a rotary positive displacement unit according to the present invention;

Figure 2 is a sectional view on the line II-II of Figure 1;

Figure 3 is a sectional view on the line III-III of Figure 1; and

Figure 4 is a sectional view on the line IV-IV of Figure 1.

The rotary positive displacement unit comprises a two-part housing 10, 11 in which is mounted two rotors 13, 14. Each rotor has a face formed with regularly spaced and radially extending teeth 15, 16 respectively, there being one more tooth on one rotor than on the other. The form of these teeth 15, 16 and a method of producing the teeth on members is fully described and claimed in the specification of patent no. 1 273 987.

Rotor 13 has a shaft portion 17 journalled for rotation in housing part 10 and rotor 14 has a shaft portion 18 journalled for rotation in housing part 11.

The radially innermost ends of the teeth 15, 16 have a common internal spherical surface which sealingly engages the spherical outer surface of a collar 19 mounted on a spigot 20 projecting from rotor 13. Bearing units 21 by means of which shaft portions 17, 18 of rotors 13, 14 are journalled are also arranged to prevent the members from separating from each other. The rotors 13, 14 are arranged to rotate relative to each other due to there being one more tooth on one rotor than on the other and in a manner described in detail in the specification of British patent no. 1 099 085. The axis of rotor 13 is inclined relative to the longitudinal axis of the housing and thus the axes of relative rotation of the two rotors 13, 14 are inclined with respect to each other whereby relative rotation between the rotors can be caused by the rotation of both rotors relative to the housing so that the teeth of the rotors move alternately into and out of mesh to produce a cyclic variation of the volumes between the teeth of the rotors 13, 14.

Portions of the rotors 13, 14 adjacent to and including the teeth have a common spherical outer surface. A ring assembly comprising two ring elements 22 and 23 define a common spherical internal surface which sealingly engages the common spherical outer surface of the rotors 13, 14. The ring elements 22, 23 abut each other at a plane perpendicular to the axis of rotation of rotor 14 and extending through the single central notional point through which pass all radial lines on which the working faces of the teeth lie. The ring elements 22 and 23 have cylindrical outer surfaces and are received in a cylindrical socket formed in housing part 11. Suitable seals 24 are provided between the ring elements 22, 23 and the housing parts 10, 11.

The unit is intended for use as a hydraulic fluid pump and the direction of rotation of the rotors 13, 14 is indicated by the arrows "A" on the accompanying drawings. In one rotation of the rotors 13, 14 there is an ment of the rotors where the volumes between the teeth of the rotors are increasing and an arc of movement where the volumes between the teeth of the rotors are decreasing. The housing is provided with ducts, a first one of which is an inlet duct 25 including a portion 26 defined between the outer face of the first ring element 23 and a groove 27 in the wall of housing part 11. The groove 27 extends circumferentially over a selected length of the arc of movemetn of the rotors where the volumes between the teeth 15, 16 of the rotors 13, 14 are increasing. The first ring element 23 of the ring assembly is apertured to enable fluid communication to take place between the exterior of the housing through the duct 25, 26 and the volumes between the teeth of the rotors in the arc of movement of the rotors 13, 14 where the volumes are increasing. This first ring element 23 is apertured with a series of apertures 28 circumferentially spaced apart over a similar selected length of the arc of movement of the rotors 13, 14 where the volumes between the teeth are increasing. Each of the apertures has a non-return valve 29 permitting flow only from the duct 25, 26 into the rotors 13, 14.

A duct 30 functions as an outlet duct and has a portion 31 defined between the outer face of the second ring element 22, and a groove 32 in the wall of the housing part 11, the groove 32 extending circumferentially over a selected length of the arc of movement of the rotors where the volumes between the teeth of the rotors 13, 14 are decreasing. The ring element 22 is apertured over a similar selec-

ted length of the arc of movement of the rotors 13, [redacted] where the volumes between the teeth 15, 16 are decreasing. The ring element 22 is apertured with a series of apertures 31 circumferentially spaced apart each aperture 33 having a non-return valve 34 permitting flow only from the rotors 13, 14 into the outlet duct 30, 31. In this embodiment the ring element 22 is restrained from rotation relative to the housing by engagement with a peg 35 projecting from the wall of housing part 11.

Ring element 23 is arranged to be rotated adjustably relative to the housing by means of a handle 36 projecting from the ring element 23 through a slot 37 in the wall of the housing part 11. As is indicated in Figures 3 and 4 of the accompanying drawings the slot 37 in the housing is sufficiently long to enable the ring element 23 to be located with all the apertures 28 available for fluid communication with the portion 26 of the inlet duct or to be adjustably rotated until all but one of the apertures 28 is out of communication with the duct 25, 26. Thus in the fullest flow position of the ring element 23 fluid communication is enabled over a selected length of and to a given point in the arc of movement of the rotors 13, 14 where the volumes are increasing and as the ring element 23 is rotated in the opposite direction to the rotation of the rotors 13, 14 the length of the arc of movement in which fluid communication is enabled is shortened and the point at which that fluid communication is terminated is made earlier. Thus for a given speed of rotation the output of the unit operating as a pump can be regulated as the amount of fluid which is permitted to enter each volume between the teeth 15, 16 of the rotors 13, 14 is regulated.

The unit described herein is particularly suitable for use in a hydrostatic transmission system including a fluid coupling comprising a rotary positive displacement unit "of the kind described" and such as that described in and illustrated in Figure 2 of British Patent Specification No. 1273987. An input shaft of such a fluid coupling is arranged to drive the shaft 18 which is the input shaft of the unit herein described and the fluid coupling and the unit are hydraulically connected together in series. The necessary connections and other components of the hydraulic circuitry will be readily apparent to those skilled in the art and need not be described in this specification.

It is preferable to arrange that the maximum fluid output of the unit according to the invention can exceed the fluid flow rate of the coupling at any given speed of rotation of the input shaft of the coupling in order that a reverse direction rotation of the output shaft of the coupling can be obtained. The spacing of the apertures 28 and 33 in the series of apertures in the ring elements 23 and 22 respectively is such that no volume between the teeth 15, 16 can communicate with more than one aperture at any given point in the rotation of the rotors. The non-return valves have the effect of making each volume between the teeth perform a pumping action independently of any other volume.

The handle 36 comprises an internally screw-threaded part 38 engaged on an externally screw-threaded rod 39 projecting radially outwards from the ring element 23. The handle 36 is thus readily retained in a selected angular position in the slot 37 by screwing the part 38 against the outer surface of the housing part 11. In another construction retention of handle 36 could be obtained by a resiliently pressed friction pad.

The parts 10, 11 of the housing are secured together by bolts 40.

In the hydrostatic transmission system a relief valve would be provided to enable excess fluid to return to a reservoir of the system.

In a modification (not shown) of the pump described above valves 29 could be dispensed with and the series of apertures 28 replaced by a single aperture in the form of a slot. In a further modification the series of apertures 33 in ring element 22 could continue around the entire circumference of the element so that a number of apertures 33 would always be in a position to enable fluid communication into duct 30, 31 whatever the angular orientation of the element might be.

WHAT I CLAIM IS:—

1. A rotary positive displacement unit of the kind described and in which the axes of relative rotation of the rotors are fixed relative to the housing and both the rotors rotate relative to the housing, wherein the rotors are located in a ring assembly comprising two or more ring elements defining a common spherical internal surface which sealingly engages the common spherical outer surface of the rotors, the ring assembly being apertured to enable fluid communication to take place between the exterior of the housing, through ducts in the housing, and the volumes between the teeth of the rotors in the arc of movement of the rotors where the volumes are increasing and in the arc of movement of the rotors where the volumes are decreasing.

2. A unit according to claim 1 wherein a first one of the ring elements is apertured to enable fluid communication with the volumes between the teeth in the arc of movement of the rotors where

the volumes are increasing and wherein a second one of the ring elements is apertured to enable fluid communication with the volumes between the teeth in the arc of movement of the rotors where the volumes are decreasing.

3. A unit according to claim 2 wherein the first ring element is arranged to enable fluid communication with the volumes between the teeth over a selected length of and to a given point in the arc of movement of the rotors where the volumes are increasing, and this first ring element is adjustably movable relative to the housing to shorten that length and to terminate fluid communication at an earlier point in the arc of movement of the rotors.

4. A unit according to either claim 2 or claim 3 wherein the first ring element is apertured to enable fluid communication with a series of apertures circumferentially spaced apart.

5. A unit according to claim 4 wherein each aperture of the series has a non-return valve.

6. A unit according to claim 2 or any preceding claim dependant upon claim 2 wherein the second ring element is arranged to enable fluid communication with the volumes between the teeth over a selected length of the arc of movement of the rotors where the volumes are decreasing.

7. A unit according to claim 6 wherein the second ring element is apertured to enable fluid communication with a series of apertures circumferentially spaced apart.

8. A unit according to claim 7 wherein each aperture of the series has a non-return valve.

9. A unit according to any one of the preceding claims and arranged to function as a pump for liquid and wherein a first one of the ducts in the housing is an inlet duct and communicates with the volumes between the teeth of the rotors in the arc of movement where the volumes are increasing, a second one of the ducts in the housing being an outlet and communicating with the volumes between the teeth of the rotors in the arc of movement where the volumes are decreasing.

10. A unit according to any one of the preceding claims wherein one of the ducts in the housing includes a portion defined between the outer face of the ring assembly and a groove in a wall of the housing surrounding the ring assembly, the groove extending circumferentially over a selected length of the arc of movement of the motors where either the volumes are increasing or decreasing.

11. A hydrostatic transmission system including a rotary positive displacement unit according to any one of the preceding claims.

12. The system according to claim 11 and including a fluid coupling comprising a rotary positive displacement unit of the kind described.

13. The system according to claim 12 wherein an input shaft of the fluid coupling is arranged to drive an input shaft of the unit and wherein the fluid coupling and unit are hydraulically connected together in series whereby a variation in the speed of the input shaft of the fluid coupling causes a variation in the fluid flow rate of the unit and of the fluid coupling.

14. A rotary positive displacement unit substantially as described herein with reference to and as shown in the accompanying drawings.

15. A hydrostatic transmission system substantially as described herein and including a unit according to claim 14.

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1472291 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

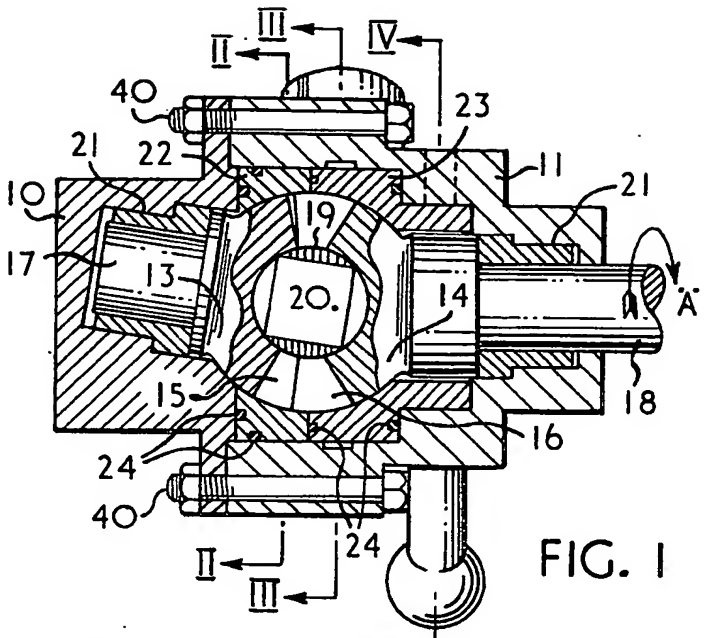

FIG. 1

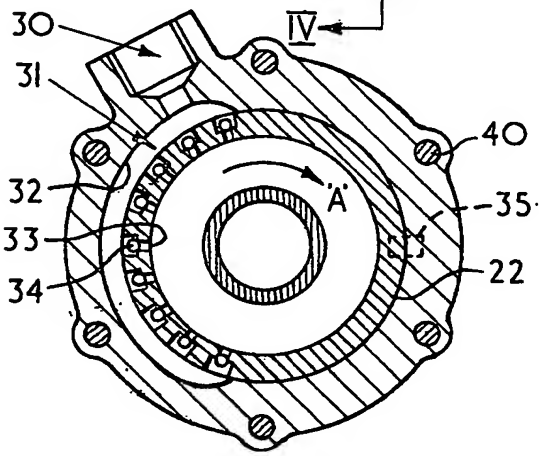

FIG. 2

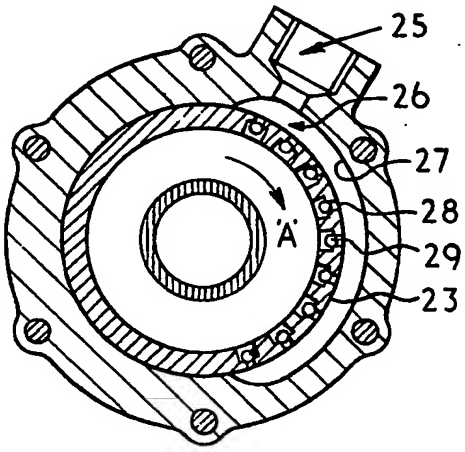

FIG. 3

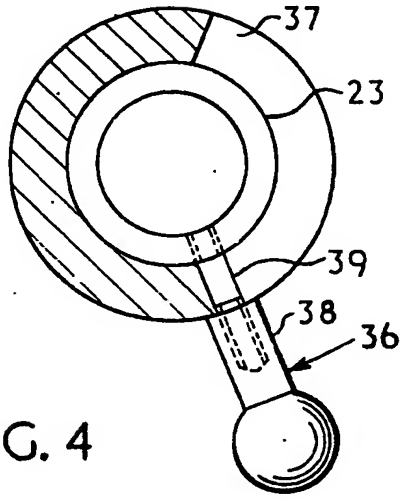

FIG. 4